Appendix G

White Mesa Mill Operations

G1.0 Introduction

White Mesa Mill is a U.S. Nuclear Regulatory Commission (NRC)-licensed mill that produces uranium for commercial nuclear power plants. The White Mesa uranium/vanadium mill was developed in the late 1970s by Energy Fuels Nuclear, Inc. (EFN) as an outlet for the many small mines that are located in the Colorado Plateau and for the possibility of milling Arizona Strip ores. Although the White Mesa Mill facility is a candidate site for possible permanent disposal of the Moab tailings, the facility also operates periodically as an NRC-licensed mill under Source Material License SUA-1358. White Mesa Mill's Source Material License allows the mill to create and dispose of uranium by-product materials from mill operations. Because of the recent history of periodic operations, the continued operations of the mill into future years is considered a reasonably foreseeable action with respect to cumulative impact analysis for the Moab tailings project. Although it is not known how long into the future the mill will operate, it is reasonable to assume that continued operations similar to those of the past 10 years are possible, since the facility's license does not expire until March 31, 2007.

G2.0 Background

The Source Material License application for the White Mesa Mill was submitted to NRC on February 8, 1978. Construction on the tailings area began on August 1, 1978, with the removal of earth from the area of Cell 2. Cell 2 was completed on May 4, 1980, Cell 1 on June 29, 1981, and Cell 3 on September 2, 1982. In January 1990, an additional cell, designated 4A, was completed and placed into use solely for solution storage and evaporation. The first ore was fed to the mill grizzly on May 6, 1980 (IUC 2000).

At the time of the mill's construction, it was anticipated that high uranium prices would stimulate ore production. However, prices started to decline about the same time as mill operations commenced. As uranium prices fell, producers in the region were affected and mine output declined. After about two and one-half years, the White Mesa Mill ceased ore-processing operations altogether, began solution recycle, and entered a total shutdown phase. In 1984, a majority ownership interest was acquired by Union Carbide Corporation's (UCC) Metals Division, which later became UMETCO Minerals Corporation (UMETCO), a wholly-owned subsidiary of UCC. From 1985 through 1990, the mill was active again in receiving and processing uranium ores. The partnership between UMETCO and EFN continued until May 26, 1994, when EFN reassumed complete ownership. Beginning in the mid- to late- 1990s, the mill began to process uranium-bearing material other than natural ores from off-site locations. These "alternative feed materials" generally have consisted of uranium-bearing residues from uranium-ore processing facilities or other metal-processing facilities as well as soils contaminated with natural uranium, most of which has come from Formerly Utilized Sites Remedial Action Program sites managed by the Army Corps of Engineers (NRC 1999). In May 1997, International Uranium (USA) Corporation (IUC) purchased the assets of EFN and is the current owner of the facility.

G3.0 Facility

The White Mesa Mill is located in San Juan County, Utah, approximately 5 miles south of Blanding, Utah. Facilities consist of a mill, ore storage pad, and four lined tailings cells with leak detection systems and ground water monitor wells. The facilities are situated within a 5,415-acre private property mostly owned by IUC. The mill itself occupies approximately 50 acres, and the tailings disposal ponds occupy approximately 450 acres. A one-half-mile-long private road off US-191 provides access to the site.

The ore storage pad at the site covers an area of approximately 20 acres. The pad is underlain by compacted, mostly fine-grained material. Crushed limestone was reported to have been incorporated into the pad at the time of construction. The surface of the pad is sloped to promote drainage and prevent off-site movement of drainage.

The tailings facilities at White Mesa Mill consist of four cells:

- Cell 1, constructed with a 1.2-inch polyvinyl chloride (PVC) earthen-covered liner, is used to store the process solution.
- Cell 2, constructed with a 1.2-inch PVC earthen-covered liner, is used to store the barren tailings sands.
- Cell 3, constructed with a 1.2-inch PVC earthen-covered liner, is used to store the barren tailings sands and solutions.
- Cell 4A, constructed with a 1.6-inch high-density polyethylene liner, is currently not used.

Total estimated design capacity of Cells 2, 3, and 4A is approximately 6 million cubic yards (IUC 2000).

G4.0 Operations

Although originally designed for a capacity of 1,500 dry tons per day, the mill capacity was boosted to the present rated design of 1,980 dry tons per day prior to commissioning. Under current and recent operations, alternative feed materials are received at the site by truck and temporarily staged until a sufficient quantity is received to run the mill.

Feed materials for the mill are temporarily stockpiled on the ore pad. The period that materials are stockpiled varies but is typically about 2 years. Feeds currently stored on the site in piles typically cover an area of approximately 0.1 to 1.5 acres and often merge. Pile thicknesses vary but may exceed 30 feet (ft). Mill operations are periodic; when operations are under way, the mill typically employs between 70 and 100 full-time employees.

Once operations commence, the feed materials are either passed through the ore-receiving hopper and semiautogenous grinding mill or run through an existing trammel before being pumped into pulp storage tanks, where a leaching process is initiated by addition of sulfuric acid. The mill currently uses propane to fire all process and heating boilers.

The mill uses an atmospheric hot acid leach followed by countercurrent decantation (CCD). This in turn is followed by a clarification stage, then a solvent extraction (SX) circuit. Kerosene containing isodecanol and tertiary amines extracts the uranium and vanadium from the solution in the SX circuit. Salt and soda ash are then used to strip the uranium and vanadium from the organic phase.

After extraction from the SX solution, uranium is precipitated with anhydrous ammonia, dissolved, and reprecipitated to improve product quality. The resulting precipitate is then washed and dewatered using centrifuges to produce a final product called "yellowcake." The yellowcake is dried in a multiple-hearth dryer and packaged in drums weighing approximately 800 pounds for shipping to conversion plants. The current NRC license for the facility specifies a maximum production rate of 4,380 tons of yellowcake per year.

After the uranium is stripped from the pregnant SX solution, the vanadium in the remaining solution is transferred to tertiary amines contained in kerosene and concentrated into an intermediate product called vanadium product liquor (VPL). An intermediate product, ammonium metavanadate (AMV), is precipitated from the VPL using ammonium sulfate in batch precipitators. The AMV is then filtered on a belt filter and, if necessary, dried. Normally, the AMV cake is fed to fusion furnaces where it is converted to the mill's primary vanadium product, vanadium pentoxide (V_2O_5).

Tailings produced by the mill typically contain 30 percent moisture by weight, have an in-place dry density of 86.3 pounds per cubic foot (Cell 2), have a particle size distribution that is predominantly a −325 mesh size fraction, and have a high acid and flocculent content (IUC 2000).

Constructed in shallow valleys or swale areas, the lined tailings cells provide storage below the existing grade and reduce potential exposure. Because the cells are separate, individual cells may be reclaimed as they are filled to capacity. This phased reclamation approach attempts to minimize the amount of tailings exposed at any time.

Slurry is disposed of in both Cells 2 and 3. Tailings in Cell 2 were placed using the perimeter discharge method. Perimeter discharge involves setting up discharge points around the east, north, and west boundaries of the cell. This method results in low-cost disposal at first, followed by higher disposal costs toward the end of the cell's life. In Cell 3, a process called the final grade method has been used, whereby the slurry is discharged until the tailings surface reaches final grade. The discharge points are set up in the east end of the cell, and the final grade surface is advanced to the slimes pool area. When the slimes pool is reached, the discharge points are then moved to the west end of the cell and worked back to the middle. As described by IUC in its reclamation plan, an advantage to using the final grade method is that maximum stability is achieved by (1) allowing water to drain from the sands to the maximum extent, and (2) allowing coarse sand deposition to help provide stable beaches. Another advantage is that radon release and dust prevention measures (through the placement of the initial layer of the final cover) are applied as expeditiously as possible.

As a zero-discharge facility, the White Mesa Mill must evaporate all of the liquids used during processing. This evaporation takes place in two areas: Cell 1, which is used for solutions only, and Cell 3, in which tailings and solutions exist.

The original engineering design indicated that a net water gain into the cells would occur during mill operations. In addition to natural evaporation, spray systems have been used occasionally to enhance evaporation rates and control dust. To minimize net water gain, solutions are recycled from the active tailings cells to the maximum extent possible. Solutions from Cells 1 and 3 are brought back to the CCD circuit, where additional extraction can be realized. Recycling to other parts of the mill circuit is not feasible due to the acid content of the solution.

G5.0 Air and Radioactive Emissions

Air emissions from the White Mesa Mill are regulated by the State of Utah in accordance with the mill's air quality permit issued in 1997 (Utah DAQE-884-97). The air quality permit establishes annual emissions limits for the yellowcake dryers and vanadium circuit scrubber. The permit also describes emission controls for sources in the mill and general procedures for controlling dust from roads and fugitive sources. Specifically, the permit requires that particulate (PM_{10}) emissions to the atmosphere shall not exceed 0.40 pound per hour for each yellowcake dryer and 2.50 pounds per hour for the vanadium circuit scrubber. The mill is also required to submit to the Utah Department of Environmental Quality an annual emissions inventory (Table G−1). Table G−1 is based on the 5 years of operation from 1997 through 2002 and shows the amounts of emissions that might be expected from future mill operations.

Table G–1. Air Emission Inventory for Key Criteria Emissions (tons per year)

Year	PM_{10}	Sulfur Dioxide	Nitrogen Dioxide	Volatile Organic Compounds	Carbon Monoxide
1997	0.775	0.255	3.859	2.120	7.257
1998[a]	–	–	–	–	–
1999	2.57	1.15	18.11	2.16	14.14
2000	1.9	1.47	14.61	2.76	11.78
2001[a]	–	–	–	–	–
2002	0.68	0.98	9.04	1.80	11.49

[a]IUC was not required to file an air emission inventory for these years because it was determined that the mill did not realize a change of 5 percent or more in emissions for any criteria pollutant reported in the previous year.
Source: IUC 2003
Note: PM_{10} = particulate matter less than 10 micrometers in diameter.

As required by 10 CFR 20.1101, the mill employs procedures and engineering controls, to the extent practicable, to achieve occupational radiological doses and doses to members of the public as low as reasonably achievable. Under 10 CFR 20.1301, NRC has adopted the U.S. Environmental Protection Agency's (EPA's) annual dose limit of 25 millirem (mrem) (exclusive of radon) for members of the public for doses attributable to licensed operations. Doses from natural background or medical radiation are excluded. In addition, the highest dose any individual member of the public should receive from direct air emissions of radioactive material to the environment should not exceed 10 mrem/year from plant emissions. On the basis of past analyses by NRC, the predicted total effective dose equivalent to a receptor at the potential nearest residence would have been a small fraction of the 25-mrem standard (IUC 2003).

G6.0 Past and Recent Production

From May 6, 1980, to February 4, 1983, the mill processed 1,511,544 tons of ore and other materials. During a second operational period from October 1, 1985, through December 7, 1987, 1,023,393 tons were processed. During a third operational period from July 1988 through November 1990, 1,015,032 tons were processed. During the fourth operational period from August 1995 through January 1996, 203,317 tons were processed. The fifth operational period from May 1996 through September 1996 processed 3,868 tons of calcium fluoride material. Since early 1997, the mill has processed over 100,000 tons from several additional feed stocks. The total amount of materials processed from the beginning of milling operations through 2002 is 4,083,144 tons. The highest annual production of yellowcake was 3.75 million pounds per year in the 1985−1990 period.

G7.0 Transportation

The original plan for the mill was to process up to 680,000 tons of ore per year, which, using 25-ton trucks, would be 27,500 truck loads per year (78 per day based on a 7-day work week, or 109 per day based on a 5-day work week). To serve the mill with process materials, it was anticipated there would be over 20 truck trips per day bringing loads of anhydrous ammonia, sulfuric acid, and other supplies.

Yellowcake refined at the mill is shipped in 55-gallon drums that weigh an average of 800 pounds. Drums are shipped an average of 1,300 miles to conversion plants, where the yellowcake is converted to uranium hexafluoride and then to enrichment-grade uranium suitable as a fuel source for nuclear power plants. An average truck shipment contains approximately 40 drums, or 17.5 tons of yellowcake. Based on licensed production capacity of 4,380 tons of yellowcake per year, a maximum of 8,760,000 pounds of yellowcake could require shipment from the mill in a given year, or 275 truck shipments per year.

A more typical recent mill operation can be characterized by the license amendments that allowed the mill to process materials from the Molycorp's Lanthanide Division Facility in Mountain Pass, California. For the year 2002, it was estimated that the mill would receive and process up to 17,750 tons of alternative feed materials, in this case consisting of lead sulfide containing approximately 0.15 percent uranium. For this mill run, an estimated 60 to 70 trucks per week would bring the materials from California to the mill over a 60- to 90-day period, representing a 2-percent increase in truck traffic on regional roads for a 3-month period. Based on the recent past history of mill operations, it can be expected that the White Mesa Mill would undertake milling operations on a scale similar to the Molycorp project approximately every 3 years.

Each periodic operation of the mill can have adverse environmental consequences from mill operations, including transportation. These effects could be in the form of health effects for workers at the mill, air or ground water pollution, or a transportation accident resulting in the release of process chemicals or source materials into streams or other sensitive areas along the travel route to the mill. These potential adverse environmental effects would be in addition to environmental effects contributed from the permanent disposal of Moab uranium tailings at the White Mesa Mill facility. The direct, indirect, and cumulative effects of Moab tailings disposal at the White Mesa Mill site are discussed in Chapters 4.0 and 5.0.

G8.0 References

10 CFR 20. U.S. Nuclear Regulatory Commission, "Standards for Protection Against Radiation."

IUC (International Uranium [USA] Corporation), 2000. *White Mesa Mill Reclamation Plan*, International Uranium (USA) Corporation, Revision 3, July 17, Denver.

IUC (International Uranium [USA] Corporation), 2003. *Description of the Affected Environment, White Mesa Mill, Blanding, Utah*, International Uranium (USA) Corporation, May 5, Denver.

NRC (U.S. Nuclear Regulatory Commission), 1999. *Environmental Assessment for International Uranium Corporation's Uranium Mill Site, White Mesa, San Juan County, Utah*, in consideration of an Amendment to Source Material License SUA-1358 for the Approval of the Proposed Reclamation Plan. U.S. Nuclear Regulatory Commission, Division of Waste Management, Office of Nuclear Safety and Safeguards, Washington, D.C., December 23.